ITT DCD STDS LAB

INSTRUCTION BOOK

MODEL 71-3A

THREE-TERMINAL DECADE CAPACITOR

MP MASTER
MA31699

BOONTON ELECTRONICS CORPORATION

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SECTION 1

GENERAL DESCRIPTION

The Boonton Model 71-3A Decade Capacitor is a three-terminal switched decade capacitor providing values of capacitance from 1 pF to 1221 pF in increments of 1 pF, over a frequency range of 5 kHz to 1 MHz, at an accuracy of ±0.25%.

The Model 71-3A is housed in a strong, non-magnetic metal case with four rubber mounting feet. External connections are brought out to two BNC-type coaxial connectors on the rear apron. On the top of the case the 12 pushbuttons for capacitance selection are arranged in three ranks of four, marked in pF values between 1 and 500 pF. The first push on a button locks it down; the second push releases it. Buttons may be pushed in any combination.

The standard capacitors are stable, low-loss air-dielectric variables; in the higher capacitance ranges, these are paralleled with high-stability mica capacitors. A separate glass-dielectric adjustable unit is used to standardize the residual capacitance of the 71-3A to exactly 3 pF; this adjustment is made to compensate for the unavoidable small differences from unit to unit and to insure that all units will be identical in performance. The internal series inductance of the unit is not large enough to sensibly degrade the accuracy.

The overall temperature coefficient is approximately +100 ppm per degree Centigrade. Maximum rated working voltage is 200 volts dc.

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SECTION 2

APPLICATIONS

2.1 The Model 71-3A is useful as a tertiary standard of capacitance to check the calibration of capacitance bridges and meters, within the accuracy limits of the device. In production-line operations where a number of capacitance-measuring instruments are in constant use, the Model 71-3A permits fast periodic checks of calibration without a large selection of standard capacitors or removal of the working instruments to the standards room.

2.2 The Model 71-3A is a convenient standard capacitor to use in making differential measurements of capacitance. (This procedure is detailed in the instruction manual furnished with the measuring equipment). With a large selection of capacitance values literally at the operator's fingertips, the optimum standard can be quickly found. When a series of capacitance specimens are to be measured for tolerance deviation from a standard value, the 71-3A enables the operator to select a suitable value of standard to make the meter indicator read midscale; plus and minus deviations are thus easily seen.

2.3 When measuring the temperature coefficient of a specimen capacitor, the Model 71-3A can be used as the standard, fixed-temperature element in the differential method mentioned in 2.2. The specimen is mounted in the controlled oven, connected to the TEST terminals of the bridge by coaxial cables; the Model 71-3A would be connected to the DIFF terminals . Ordinarily, a correction would have to be made for the long cables; however, here it is only the change of capacitance that is to be measured, rather than an absolute value, and a precise correction is not normally necessary.

2.4 The Model 71-3A is an accurate, compact and easy-to-use decade capacitor for general laboratory use. If it is used in an active circuit, however, care must be taken to limit the voltage applied to a maximum of 200 volts.

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SECTION 3

MEASUREMENT TECHNIQUES

The series inductance of the connecting cables used between the test capacitance and the measuring instrument introduces an error into the measurement for which a correction must be made. At a measuring frequency of 100 kHz the error is small enough to be ignored; at 1 MHz, however, even with very short cables the error is large enough to require correction for capacitance measurements above 100 pF. Figure 1 shows in graphic form the corrections to be applied for different frequencies, capacitances and cable lengths. For specific values of standard capacitance at 1 MHz only, the table below may be easier to use.

TABLE 1

Standard Capacitance (pF)	Subtract per inch of cable pair (pF)	Subtract per foot of cable pair (pF)
1000	0.60	7.2
750	0.33	4.0
500	0.15	1.8
300	0.05	0.65
100	-	0.07

The Model 71-3A is recommended for use with Boonton instruments in the Model 71, 74, 75, 77 and 700 series. With all these instruments, connections and adjustments are quickly accomplished. It will also, of course, function very well with instruments of other manufacture provided they are equipped with compatible connectors.

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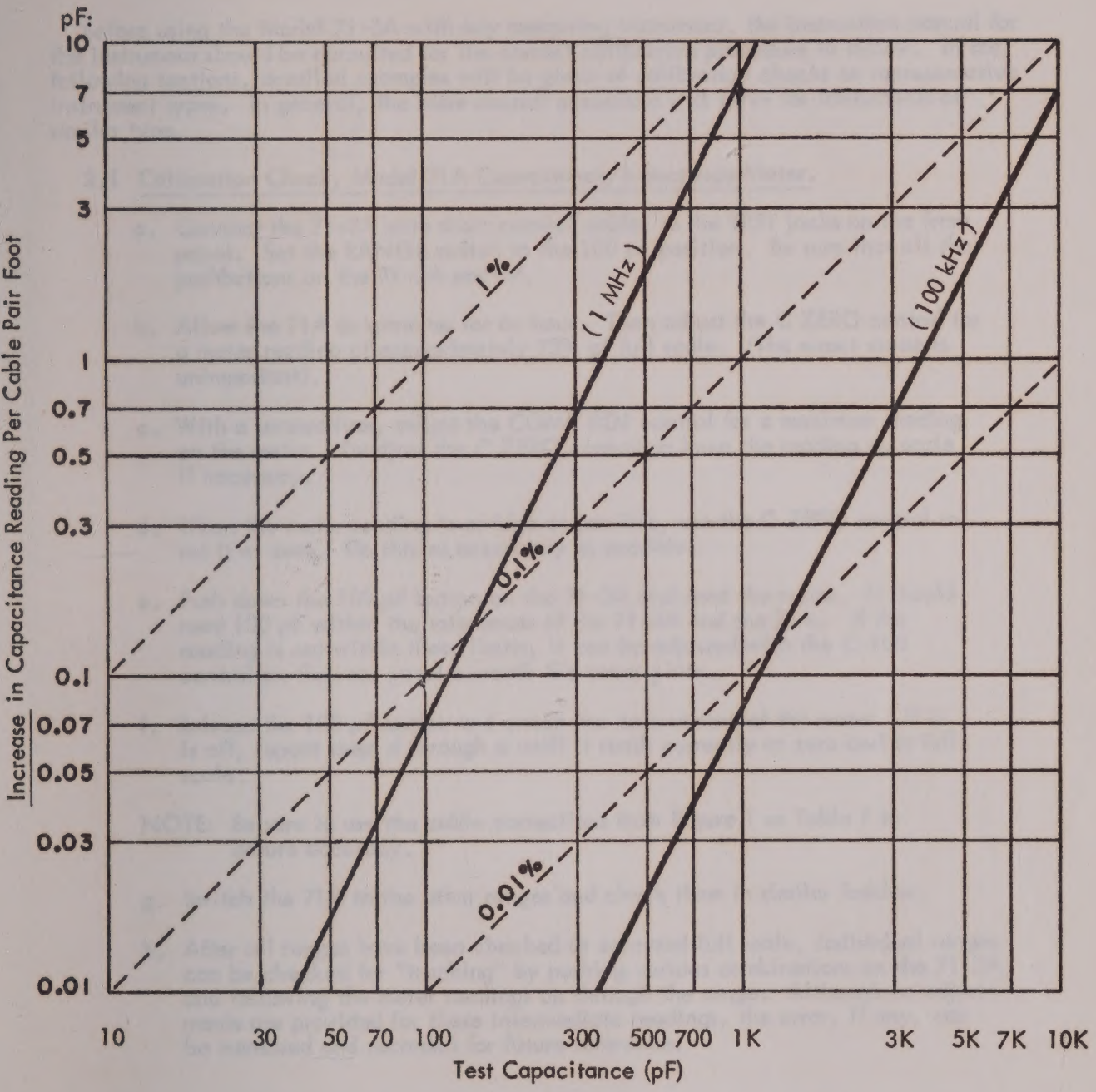

Figure 1. Measurement Error due to RG-58/U Cable Inductance

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Before using the Model 71-3A with any measuring instrument, the instruction manual for the instrument should be consulted for the correct calibration procedure to follow. In the following sections, detailed examples will be given of calibration checks on representative instrument types. In general, the same overall procedure will serve for instruments of similar type.

3.1 Calibration Check, Model 71A Capacitance/Inductance Meter.

a. Connect the 71-3A with short coaxial cables to the TEST jacks on the front panel. Set the RANGE switch to the 100 pF position. Be sure that all the pushbuttons on the 71-3A are UP.

b. Allow the 71A to warm up for an hour. Then adjust the C ZERO control for a meter reading of approximately 75% of full scale. (The exact value is unimportant).

c. With a screwdriver, adjust the COMP ADJ control for a maximum reading on the meter. Readjust the C ZERO control to keep the reading on scale if necessary.

d. When the meter reading is as high as possible, use the C ZERO control to set it at zero. Do this as accurately as possible.

e. Push down the 100 pF button on the 71-3A and read the meter. It should read 100 pF within the tolerances of the 71-3A and the 71A. If the reading is not within these limits, it can be adjusted with the C-100 control on the rear panel beneath the cover plate.

f. Release the 100 pF button and check the zero setting of the meter. If it is off, repeat steps d through e until it reads correctly at zero and at full scale.

NOTE: Be sure to use the cable corrections from Figure 1 or Table 1 to ensure accuracy.

g. Switch the 71A to the other ranges and check them in similar fashion.

h. After all ranges have been checked at zero and full scale, individual ranges can be checked for "tracking" by pushing various combinations on the 71-3A and following the meter readings up through the range. Although no adjustments are provided for these intermediate readings, the error, if any, can be measured and recorded for future reference.

3.2 Calibration Check, Model 700C Digital C/L Meter.

a. Consult the 700C Instruction Manual, Paragraphs 3.3, 3.4 and 3.7, before making this check.

b. Connect the 71-3A to the CAPACITANCE TEST HI and LO terminals of the 700C, using the shortest possible lengths of coaxial cables - preferably no longer than three inches.

c. After warm-up, set the RANGE switch to a C_{pF} position consistent with the desired test value. Be sure that all pushbuttons on the 71-3A are UP.

d. Adjust the COMP ADJ control for a maximum readout on the digital display.

e. Adjust the C ZERO control until the display reads 0.000, $\pm$ 3 on the last digit.

f. Push the desired button or button combination on the 71-3A and read the resultant figure on the display.

g. Make the required correction for cable inductance to the reading obtained.

h. If the reading is outside the combined accuracy tolerance of the 700C and the 71-3A, refer to the 700C Manual for calibration procedures.

SECTION 4

CALIBRATION

Upon specific request, the 71-3A can be supplied with a calibration certificate for the individual standard, recording the measured value at 25°C and the measured temperature coefficient based on the range between 25° and 75°. The reference standards used are traceable to the National Bureau of Standards.

It is recommended that the 71-3A be returned to the maker at periodic intervals for calibration checks. If it is dropped, or otherwise mishandled, it is advisable to have it recalibrated before further use.

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